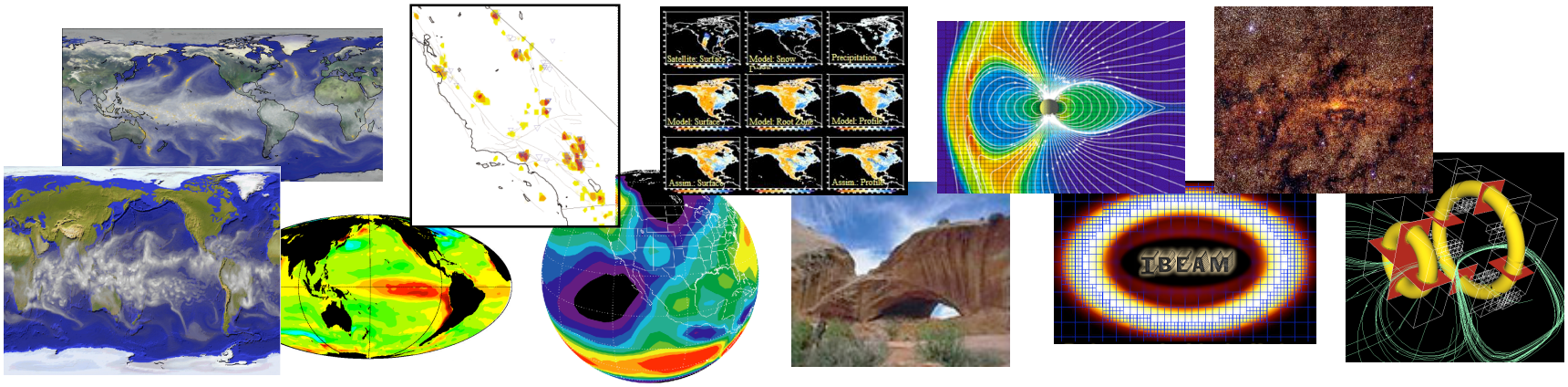
NASA Earth Science Technology Office (ESTO)

Computational Technologies (CT) Project

Project Briefing to ESTO Technology Strategy Team



Jim Fischer/GSFC, Project Manager
Robert Ferraro/JPL, Associate Project Manager

February 25, 2003

New Orleans

Round-3 Awardees

Managed via 144 negotiated milestones

CAN-00-OES-01
"Increasing Interoperability and Performance of Grand Challenge Applications in the Earth, Space, Life and Microgravity Sciences"

for the Earth System Modeling Framework

$9.8M over 3 years

T. Killeen/NCAR
Part I: Core Earth System Modeling Framework Development

J. Marshall/MIT
Part II: Modeling Applications for the Earth System Modeling Framework

A. da Silva/GSFC
Part III: Data Assimilation Applications for the Earth System Modeling Framework

in Earth Science

$6M over 3 years

A. Donnellan/JPL
Numerical Simulations for Active Tectonic Processes

P. Houser/GSFC
Land Information Systems

C.R. Mechoso/UCLA
Atmosphere-Ocean Dynamics and Tracer Transport

J. Schnase/GSFC
Biotic Prediction: HPCC Infrastructure for Public Health and Environmental Forecasting

in Space Science

$7M over 3 years

T. Gombosi/U.Mich
A High-Performance Adaptive Simulation Framework for Space-Weather Modeling (SWMF)

P. Saylor/U.Illinois
Development of an Interoperability Based Evironment for Adaptive Meshes (IBEAM) with Applications to Radiation-Hydrodynamic Models of Gamma-Ray Bursts

T. Prince/Caltech
High-Performance Cornerstone Technologies for the National Virtual Observatory

P. Colella/DoE/LLNL
A C++ Framework for Block-Structured Adaptive Mesh Refinement Methods

Report Card on CT Round-3 Investigator Milestones

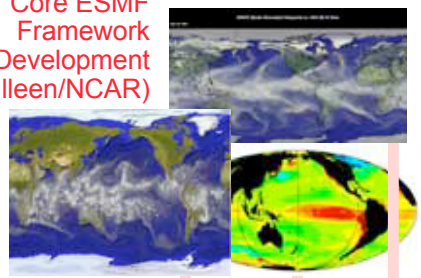
$22.8M over 3 years

ESTO
Earth Science Technology Office

Collaborations to develop software frameworks that enable more realistic simulations of natural phenomena and interpretation of vast quantities of observational data on high-end computers.

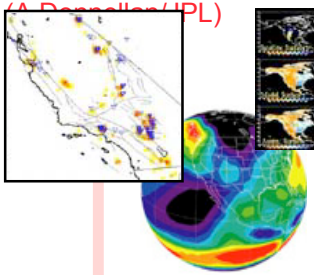
Core ESMF Framework Development (T.Killeen/NCAR)

ESMF Data Assimilation Applications (A.daSilva/GSFC)



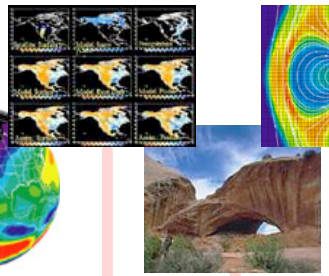
ESMF Modeling Applications (J.Marshall/MIT)

Simulation of Active Tectonic Processes (A.Donnellan/JPL)



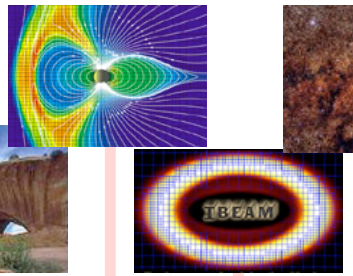
Atmosphere-Ocean Dynamics and Tracer Transport (R.Mechoso/UCLA)

Land Information Systems (P.Houser/GSFC)



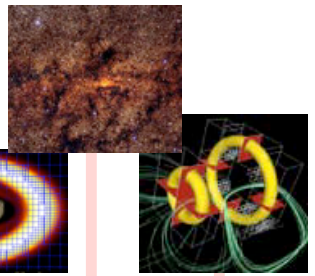
Biotic Prediction (J.Schnase/GSFC)

Framework for Space-Weather Modeling (T.Gombosi/U.Michigan)



Radiation-Hydro Models of Gamma-Ray Bursts (P.Saylor/U.Illinois Urbana-Champaign)

National Virtual Observatory Technology (T.Prince/Caltech)



C++ Framework for Block-Structured Adaptive Mesh Refinement Methods (P.Colella/LBNL)

Signed Agreement											
A -Software Engineering Plan											
E -Code baseline											
F -1st Code Improvement							submitted				
G -2nd Code Improvement											
H -Community agreement on Interoperability design policy											
I -Interoperability Prototype Tested											
J -Full Interoperability Implemented											
K -Customer Delivery											
B -1st Annual Report											
C -2nd Annual Report											
D -Final Report											

Change since last monthly report

Earth System Modeling Framework Development

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Earth Science Technology Office

Description

- Design and implement a software framework to allow climate model components from different researchers to interoperate on parallel computers

PIs

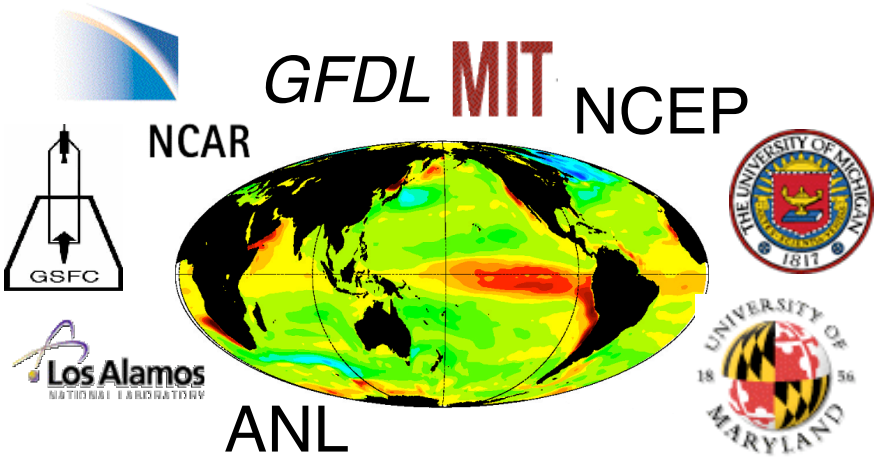
- Tim Killeen / NCAR
- John Marshall / MIT
- Arlindo da Silva / GSFC

Approach

- Gather and analyze requirements for model interoperability from the U.S. climate and weather modeling communities, as well as for data assimilation systems used with major weather and climate models
- Design the required software framework and toolkit
- Engineer, test and validate the framework against the requirements
- Convert existing model and data assimilation components to comply with and use the framework
- Test scalability and overhead of the resulting system using real modeling applications

Management

- 11 shared milestones valued at $9.8M over 3 years



The ESMF Will Assist the U.S. Climate Research Community to Advance by:

- Reducing redundant effort by scientists and software developers
- Strengthening communication and collaboration among diverse groups
- Strengthening the links between weather forecasting and climate modeling
- Increasing the portability and scalability of climate models
- Simplifying the construction of climate models and the exchange and incorporation of new submodels

Earth System Modeling Framework Rollout

19 major Earth system modeling components

All compliant by April '04

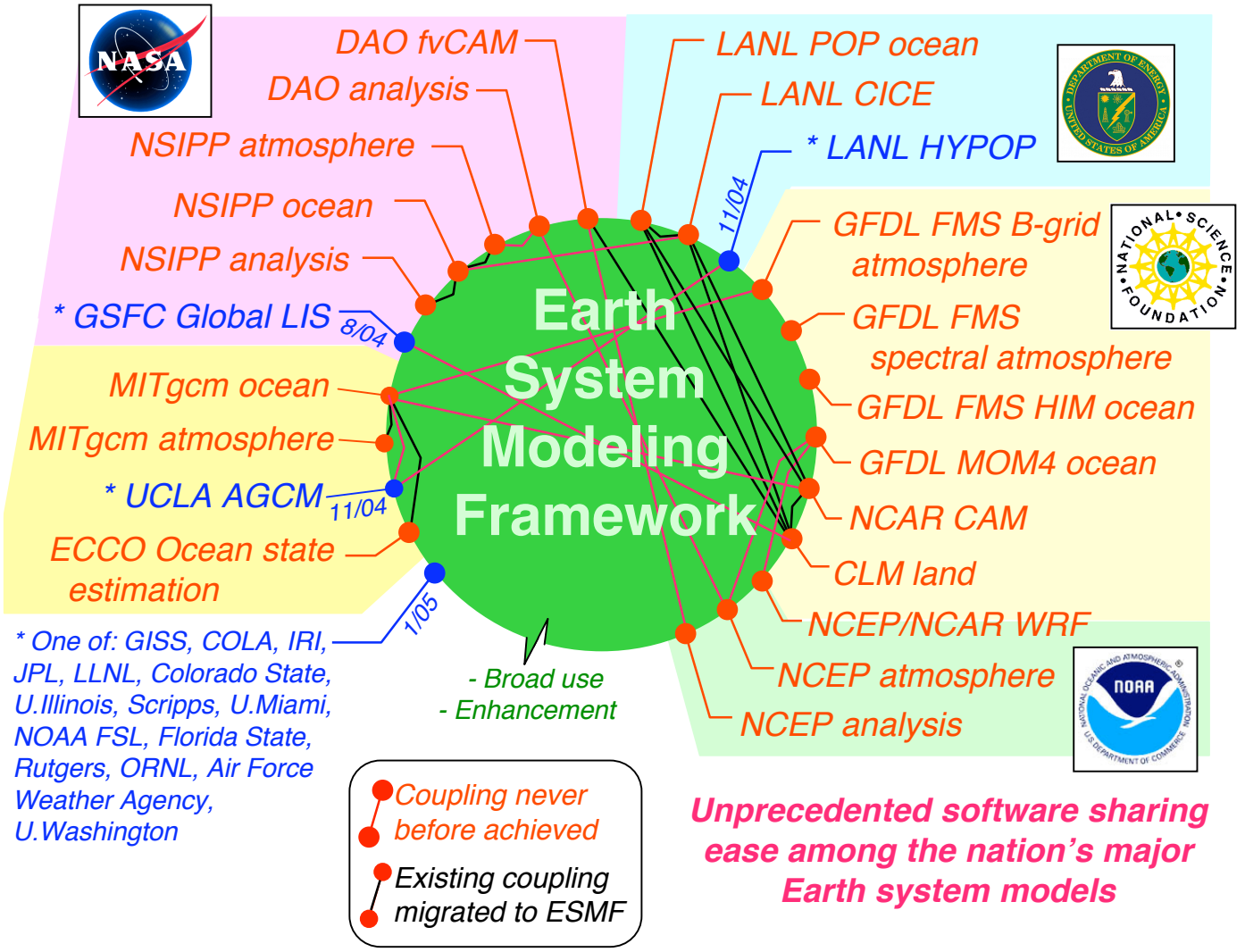
30 ESMF applications

15 research and operational

8 entirely new

7 synthetic samples

** Early adopters of the ESMF*



Unprecedented software sharing ease among the nation's major Earth system models

ESMF Science Applications and Framework Demonstrations

15 SCIENCE APPLICATIONS

GFDL B-grid atmosphere
Atmospheric science and climate research.

GFDL spectral atmosphere
Atmospheric science and climate research.

GFDL MOM4 ocean
Oceanographic and climate research.

GFDL HIM
Ocean climate system and idealized circulations.

MITgcm atmosphere + ocean
Coupled system research at a range of timescales.

MITgcm regional + global ocean
Oceanographic reseach.

NSIPP atmosphere + ocean
Seasonal/interannual variability of coupled system.

CCSM-2
Climate research and prediction.

DAO PSAS
Atmospheric data assimilation.

DAO fvCAM + CLM
Atmospheric science and climate research.

NCEP Spectral Atmosphere
Weather research and prediction.

NCEP SSI Analysis
Atmospheric data assimilation.

NCEP/NCAR WRF
Weather research and prediction.

NSIPP ocean + OI Analysis
Oceanographic data assimilation.

8 FRAMEWORK DEMONSTRATIONS

GFDL B-grid atm + MITgcm ocean
Global biogeochemistry at seasonal/interannual timescales.

GFDL MOM4 + NCEP forecast
NCEP seasonal forecasting system.

NSIPP ocean + LANL CICE
Extension of seasonal/interannual system to centennial time scales.

NSIPP atm + DAO analysis
Assimilated initial state for seasonal/interannual prediction.

DAO analysis + NCEP model
Intercomparison of systems for NASA/NOAA joint center for satellite data assimilation.

DAO fvCAM + NCEP analysis
Intercomparison of systems for NASA/NOAA joint center for satellite data assimilation.

NCAR CAM Eul + MITgcm ocean
Improved climate predictive capability: climate sensitivity to large component interchange.

NCEP WRF + GFDL MOM4
Development of hurricane prediction capability.

MITgcm Adjoint Sensitivity
Automatic adjoint capability for model sensitivity.

ESMF International Collaboration

- The ESMF and (European) PRISM teams are collaborating technically. ESMF is represented by V.Balaji/GFDL.
- They have made a precise side-by-side comparison of their different but overlapping features and goals.
- They are working to agree on where to:
  a) build common standards;
  b) "borrow", or otherwise arrive at common layers and tools; and
  c) agree to go their separate ways, because of differing goals.
  The areas of divergence are very few and there are issues where convergence will have to be deferred.
- Balaji is participating this week in the PRISM community meeting (akin to ESMF's May 15 meeting at GFDL) and the PRISM Steering Committee meeting, where discussion of the PRISM followon "PRISM-2" will address parallel European-U.S. projects working toward a convergence of ideas.
- ESMF and PRISM will also hold a joint session at EGS/AGU in Nice, France, in April including an open session to moot collaborative efforts.

Backup

Computational Technologies (CT) Project

Goal

Demonstrate the power of high-end and scalable cost-effective computing environments to further our understanding and ability to predict the dynamic interaction of physical, chemical, and biological processes affecting the Earth, the solar-terrestrial environment, and the universe. *- HPCC Program Plan - June 2000*

Objectives

- **Customer Impact**
- **Computational and Communication Performance**
- **Interoperability**
- **Portability**
- **Customer Usability**

Center-based Direct Support for Round-3 Teams

- Software engineering guidance
- ESMF risk assessment and mitigation
- Unique software product co-development
- Plug-ins software component solicitation
- Performance optimization
- High performance computing system access and data storage
- PC cluster access
- PC cluster pathfinding
- High end networking assistance
- Visualization services
- Summer school in high performance computational sciences
- Information officer